

Computer Networks

LEC :1 INTRODUCTION

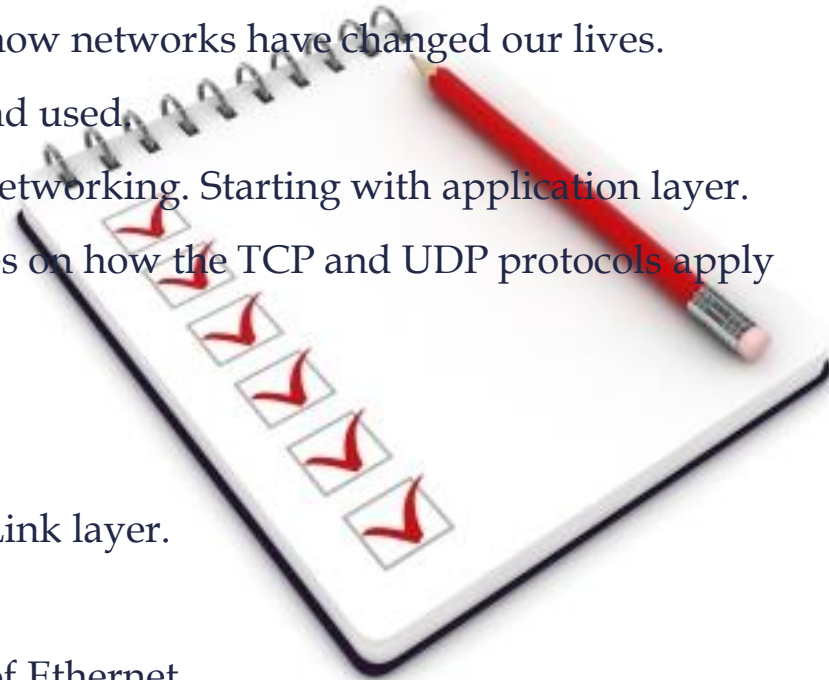
DR / MAHMOUD BADAWY



This Course

■ Our Course contains 11 main parts:

- **Chapter 1- Introduces** basics of communication and how networks have changed our lives.
- **Chapter 2** - Focuses on how networks are modeled and used.
- **Chapter 3** - Using a top-down approach to teaching networking. Starting with application layer.
- **Chapter 4** - Introduces the Transport layer and focuses on how the TCP and UDP protocols apply to the common applications.
- **Chapter 5** - Introduces the OSI Network layer.
- **Chapter 6** - Focus on network addressing
- **Chapter 7** - Discusses the services provided by Data Link layer.
- **Chapter 8** -Introduces the Physical layer.
- **Chapter 9** - Examine the technologies and operation of Ethernet.
- **Chapter 10** - Focuses on packet encoding and how you can interpret the data .
- **Chapter 11** - Connect and configure a small network using basic Cisco IOS commands for routers and switches.



Assessment Strategy

■ Assessment through the course will be via:

1. Lecture quizzes.
2. Assignments (Sheets , Reports or Lab. Activities).
3. Practical exam at LAB.
4. Mid-Term Exam.
5. Final Exam.



Lecture Policy



- You are not allowed to attend the lecture after 5 mins of its start.
- You are free to ask any time in the lecture topic.
- If you have a question out of the lecture scope, it is preferable to ask it after the lecture or at the end of it.
- Don't attend the lecture just for attendance, it won't help you. Try to gain knowledge.

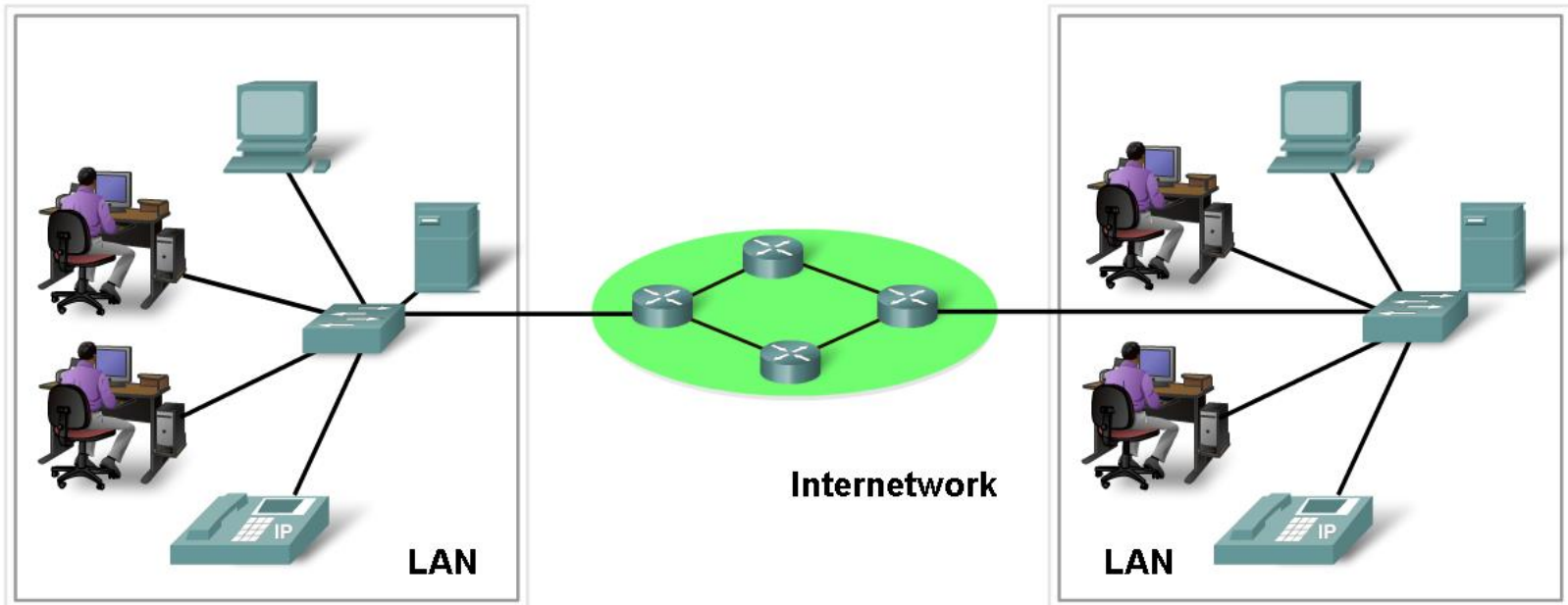


INTRODUCTION



What is the Computer Network?

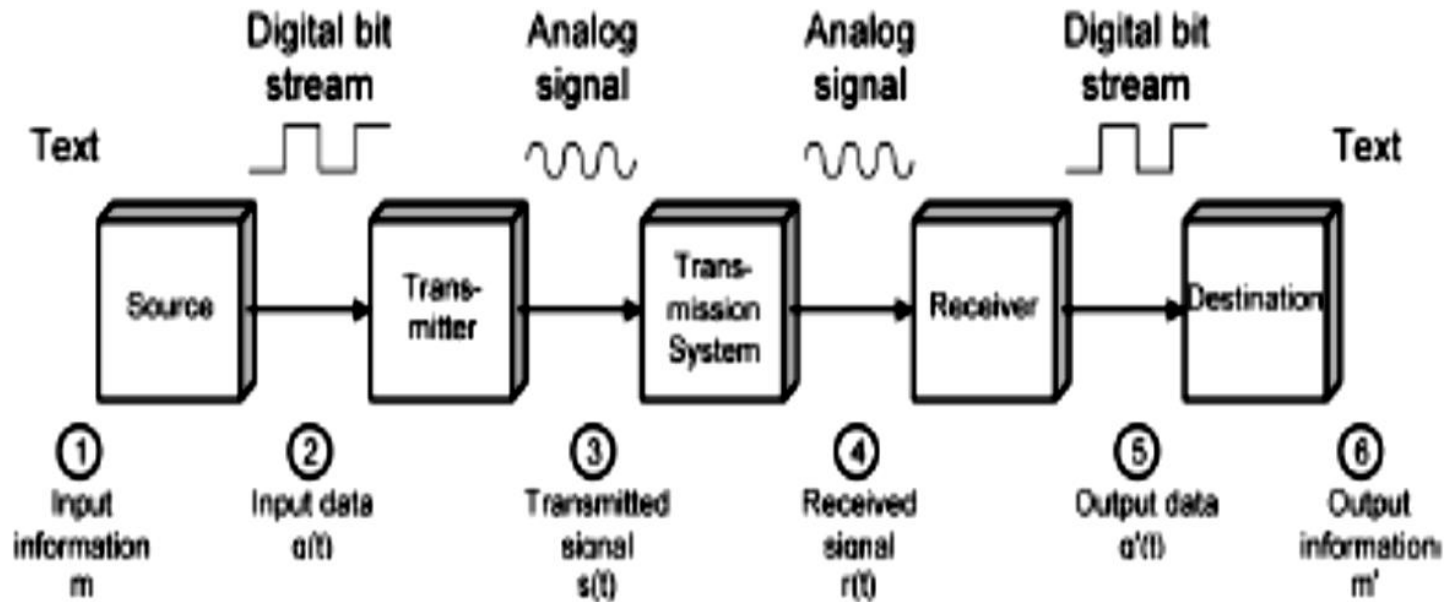
- Computer Network means, a collection of Computers, and other devices, or peripherals connected together through connecting media.



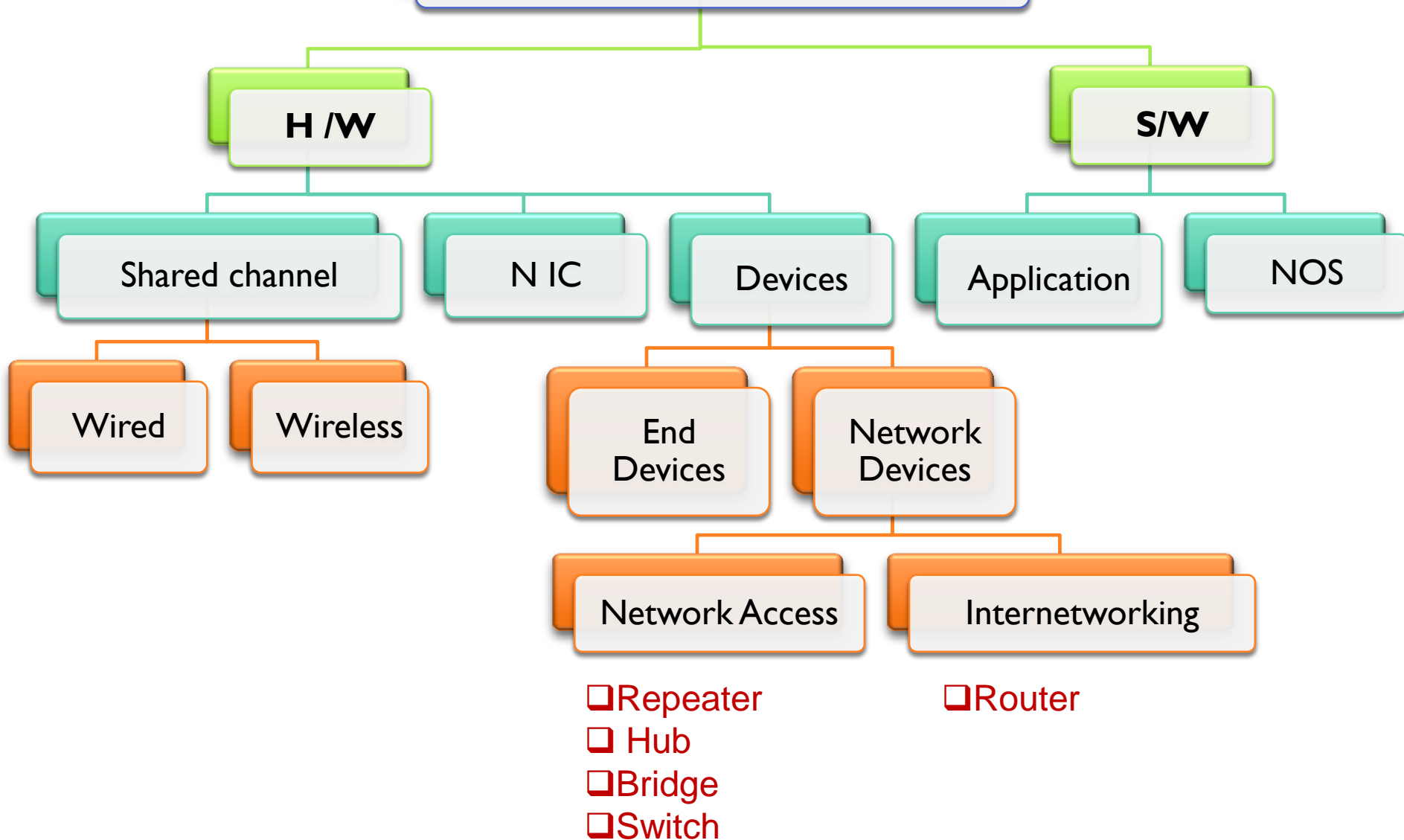
Benefits of Computer Networks

- **Easy access and sharing of information.**
- **Sharing of expensive devices and network resources:**
 - File Sharing.
 - Peripheral Sharing.
 - Software Sharing with multi-user licenses.
- **Modern Technologies (IP telephony, Video Conferencing,etc).**
- **Shared Internet Access.**

Data Communication System



Network Components



Hardware Components

1) Shared Channel (transmission media):

- ❑ Media that physically connect the computers and network devices
- ❑ It can be:
 - a) **Wired (cables) such as :**
 - **Metallic wires** - encoding into patterns of electrical impulses.
 - **Fiber optics** – encoding into pulses of light (infrared or visible light ranges)
 - b) **Wireless (Air) which** encoding patterns of electromagnetic waves.
such as :
 - Infrared.
 - Bluetooth.
 - Radio Waves
 - Microwaves.

Hardware Components (cont.)

2) NIC (Network Interface Card):

- The hardware that plugs into the motherboard and directly access the network.

3) Devices:

A) End Devices:

- Source of applications (network aware applications).
- Such as : Workstations, PCs , Servers, Printers...etc.

B) Network Devices:

- Devices that interconnect different computers together.
- Ex: Repeaters, hub, bridge, switch, router, NIC and modems

Hardware Components (cont.)

■ Network Devices can be categorized into:

I. **Network Access Devices:** Provide connectivity to the network such as:

- **Hub:** device allows different nodes to communicate with each other.
- **Switch:** Allow different nodes to communicate with each other at the same time without slowing each other down.

II. **Internetworking Devices:** Connect individual networks such as:

- **Router:** Allow different networks to communicate with each other

Hardware Components (cont.)

■ NIC:



■ Hub:



Hardware Components (cont.)

■ Switch:

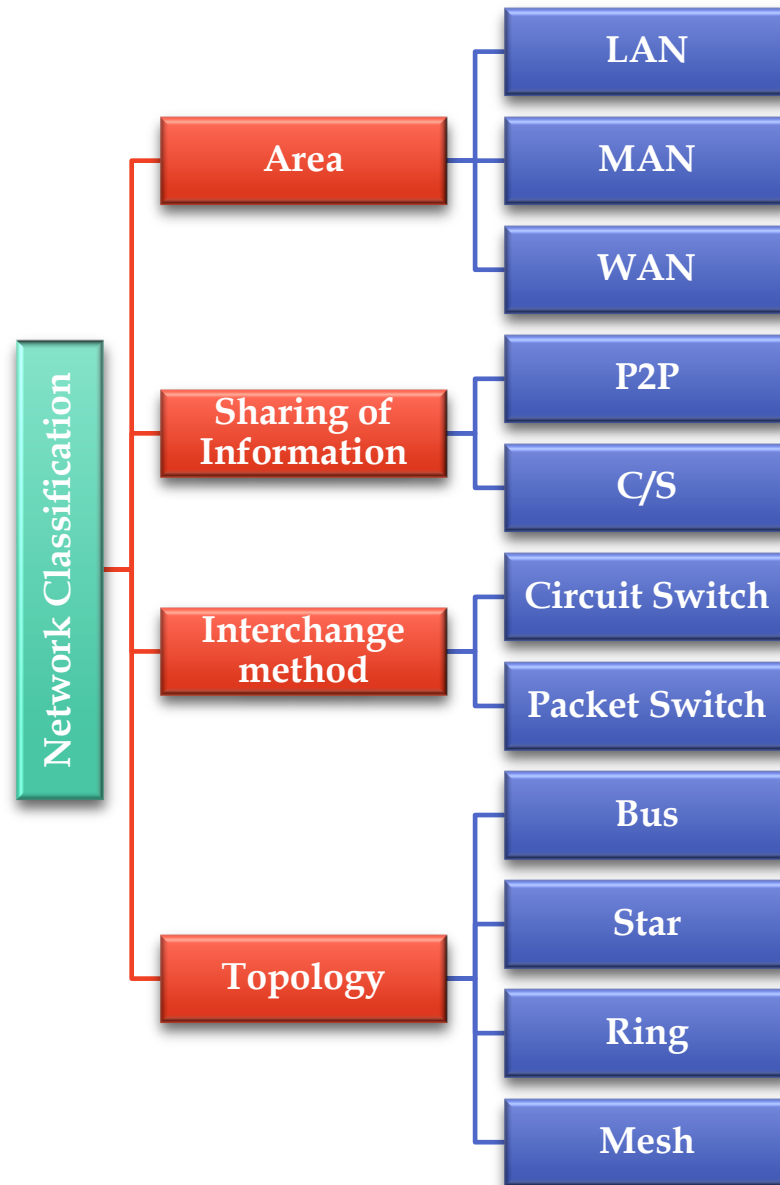


■ Router:





Classifications of Networks



Classifications of Networks

■ According to covered area:

- LAN.
- MAN.
- WAN.

■ According to network model:

- C/S.
- P2P.

■ According to network topology:

- Bus, Star, Ring, Extended Star, Mesh etc.

(1) According to covered area:

■ **Local Area Networks [LAN]:**

- A LAN is a group of computers connected in small geographical area.
- Allow users to share files and services.

■ **Metropolitan Area Networks [MAN]:**

- A MAN connects an area larger than a LAN but smaller than a WAN, such as a city.

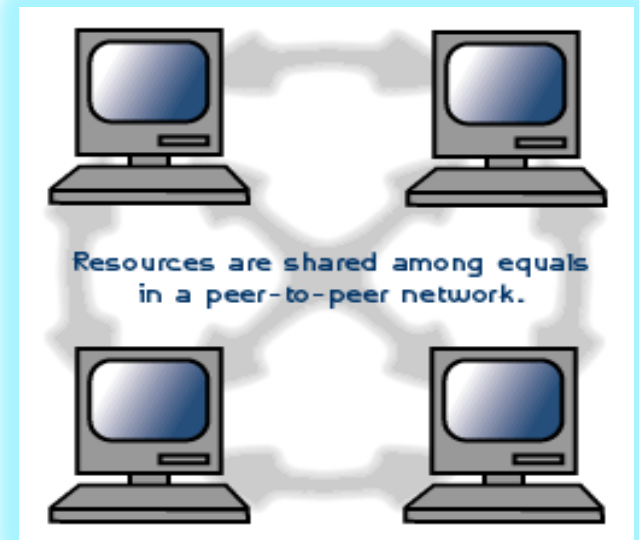
■ **Wide Area Networks [WAN]**

- A WAN is a group of computers connected in Large geographical area such as country.
- A WAN often connects two LANs (WAN Link).

(2) According Network Model:

1) Peer – too – Peer Networks (P2P):

- In a peer-to-peer network, all computers are considered equal; they all have the same abilities to use the resources available on the network.
- Example : Windows Workgroup.



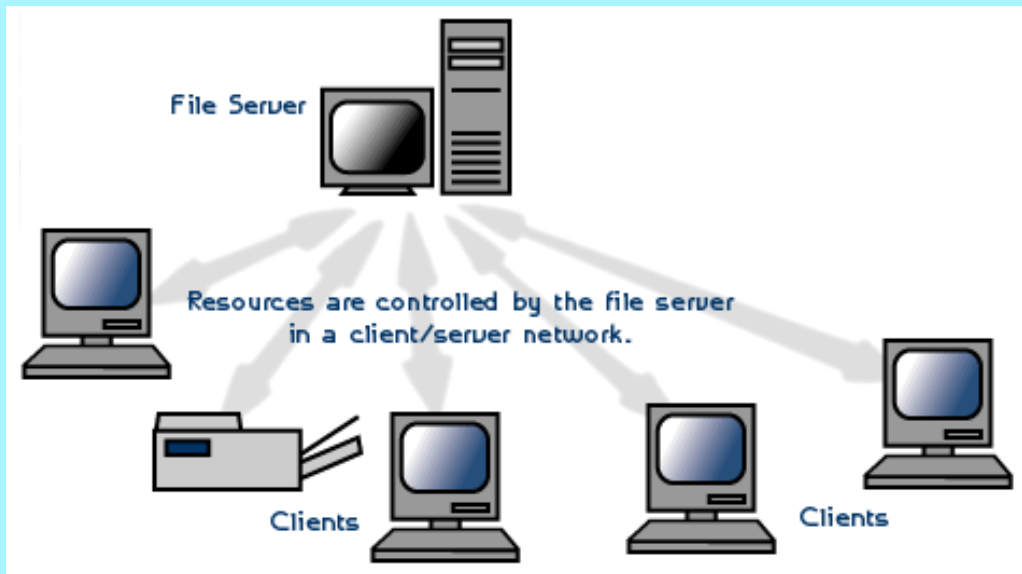
According Network Model (cont.):

2) Client / Server Networks(C/S):

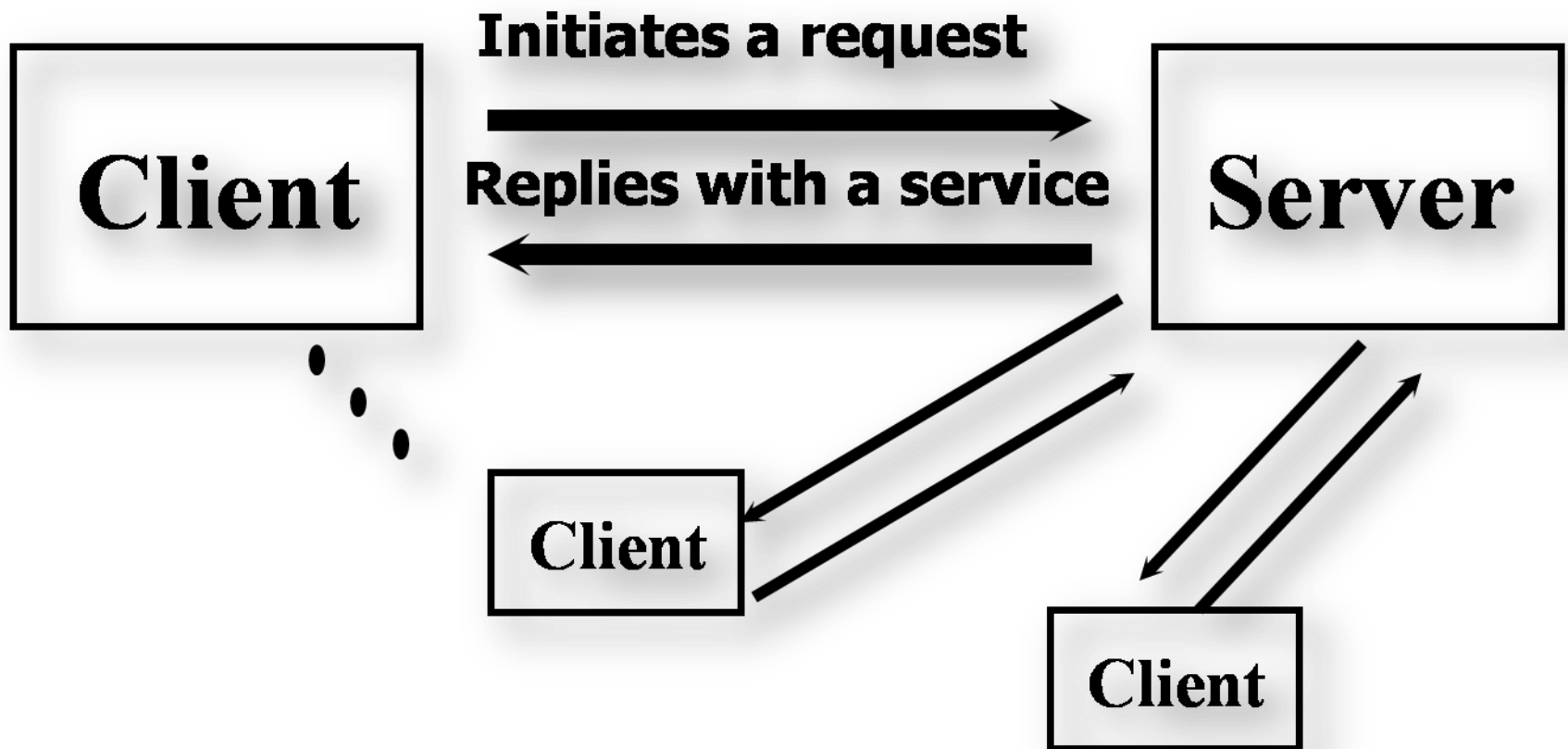
- Some nodes (SERVER) are dedicated to present services to other nodes (CLIENTS).

- Examples:

- Mail Server.
- Web Server.
- FTP Server.
- DNS Server.



Client Server Model



(3) According to Network Topology:

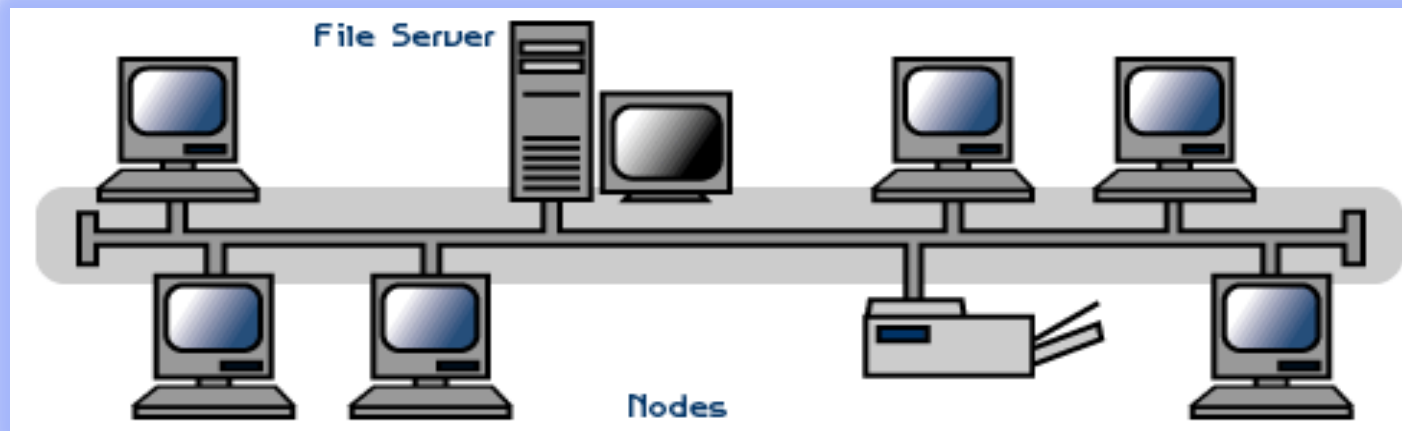
- Topology refers to the shape of a network, or the network's layout.
- How different nodes in a network are connected to each other and how they communicate are determined by the network's topology.
- The choice of topology is dependent upon
 - Type and number of equipment being used
 - Cost

According to Network Topology (Cont.):

- According to topology computer networks can be (Types of network Topologies):
 - Bus.
 - Star.
 - Ring.
 - Mesh.
 - Hybrid.

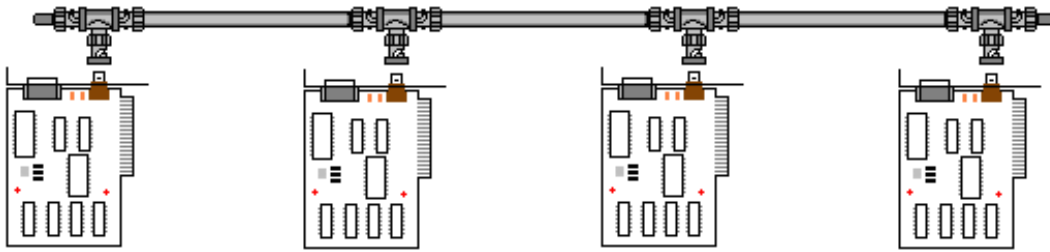
Bus Topology

- All devices are connected to a central cable, called the bus or backbone.



Bus Topology (cont.)

- Both ends of the network must be terminated with a terminator.
- A barrel connector can be used to extend the network.



Bus Topology (cont.)

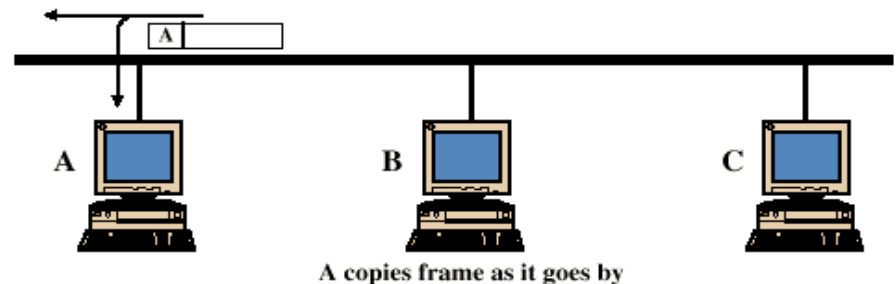
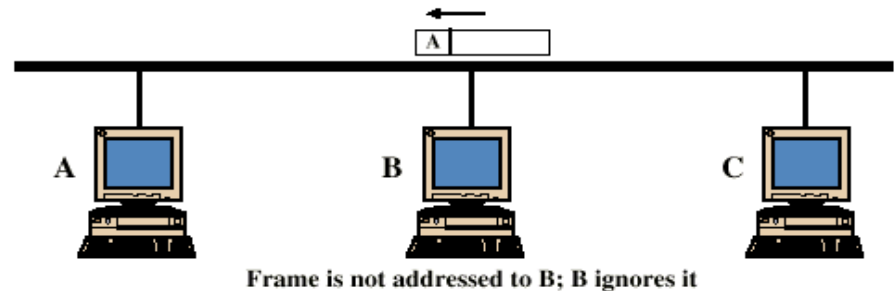
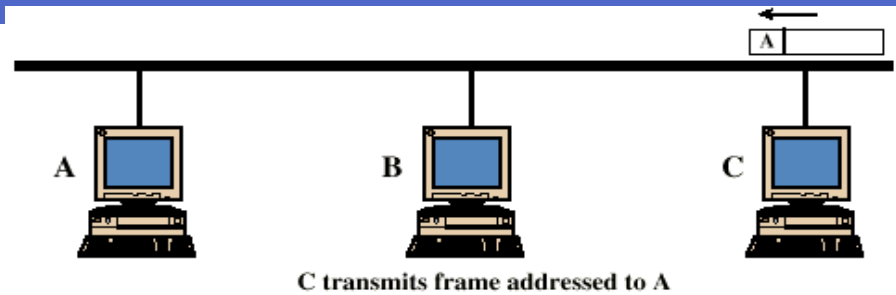
- The backbone functions as a shared communication medium
- Device wanting to communicate with another device on the network sends a message onto the backbone
- The message is heard by all stations, but only the intended recipient actually accepts and processes the message.
- Terminator absorbs frames at end of medium

Bus Topology (cont.)

Frame Transmission - Bus LAN

- **Example:**

Station C want to transmit a frame of data to station A.



Bus Topology (cont.)

Advantages & Disadvantages

□ Advantages:

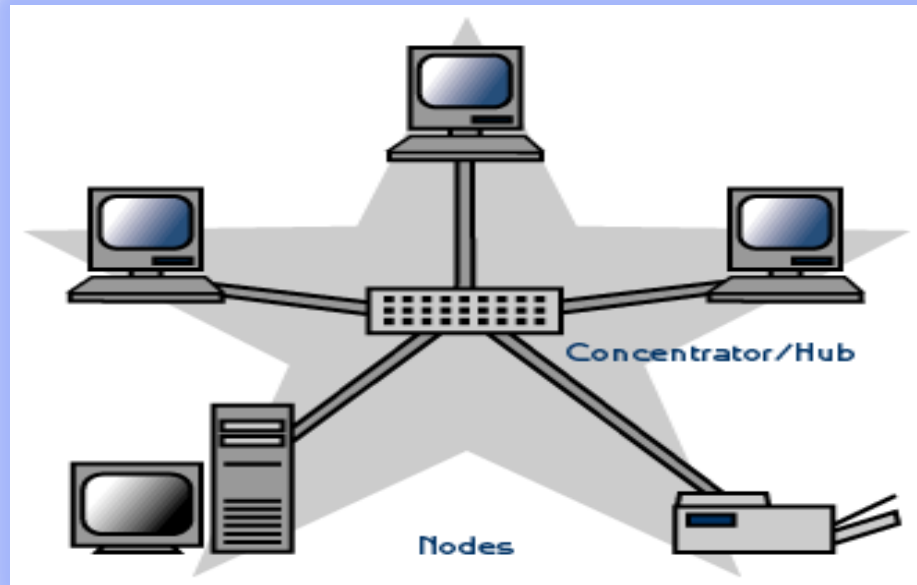
- ✓ Simple, easy to use and construct
- ✓ Requires least amount of cable (less expensive)

□ Disadvantages:

- ✓ A faulty cable will take the entire LAN down
- ✓ Difficult to troubleshoot
- ✓ Heavy network traffic can slow bus considerably

Star Topology

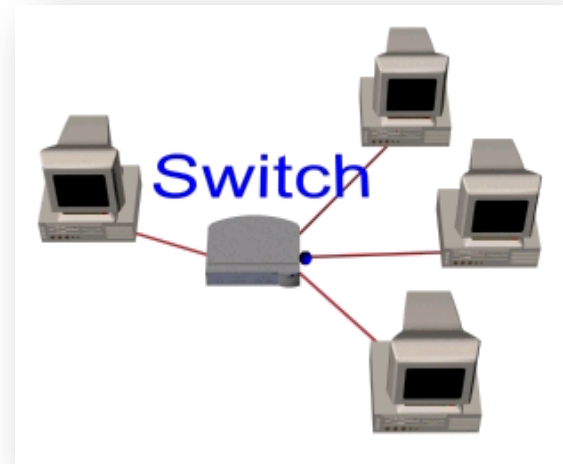
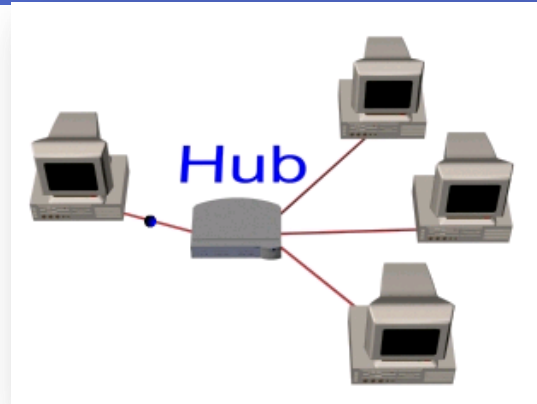
- A physical Star topology connects the devices via a centralized unit such as a Hub or Switch.
- Nodes communicate across the network by passing data through the central device.



Star Topology (cont.)

Star Types

- **Broadcasted Star Topology (Hubbed Star)**
- **Switched Star Topology (Switched Star)**



Star Topology (cont.)

Advantages

- Single computer failure doesn't bring down whole network.
- Adding new devices to a Star network is very simple compared to any of the other topologies.
- No disruptions to the network when connecting or removing devices.
- Centralized control.
- Centralized network/hub monitoring.
- Easy to troubleshoot.

Star Topology (cont.)

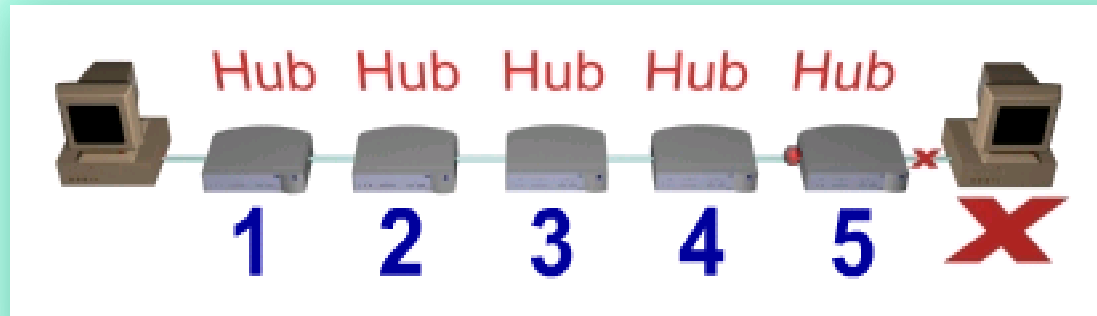
Disadvantages

- If central device fails, the whole network fails.
- Compared to the bus topology, a star network generally requires more cable.
- More expensive than linear bus topologies because of the cost of the central device.

Star Topology (cont.)

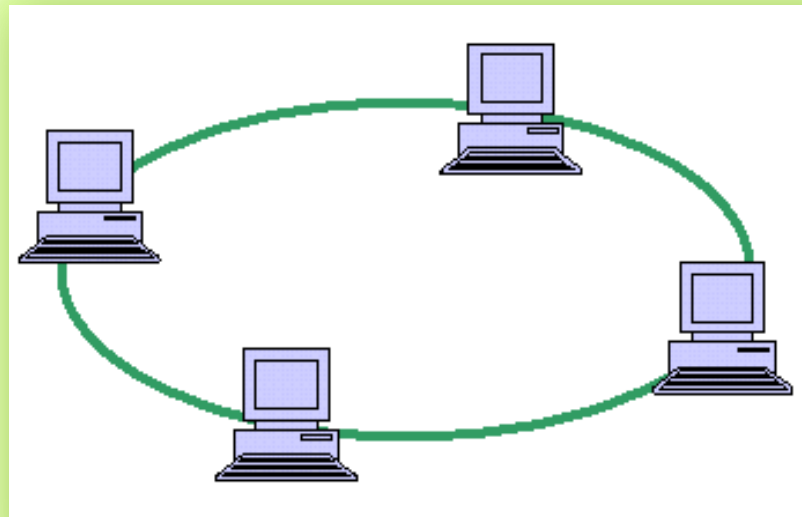
Hubbed Star Rule

- Hubs simply pass on all the information they receive.
- Therefore, a large number of directly connected hubs cause a lot of traffic, making the network vulnerable to collisions.
- This limits the number of hubs you can connect together.
- The maximum number of allowed repeater hops is four.



Ring Topology

- All devices are connected to one another in the shape of a closed loop, so that each device is connected directly to two other devices, one on either side of it.
- Data is passed one way from device to device.



Ring Topology (cont.)

- A short message (called a token) is circulated around the ring, being passed from station to station.
- The token originates from a controller or master station which inserts it onto the ring.
- A station which wants to transmit waits for the token to arrive.
- When the token arrives, the station changes it from a token to a connector message, and appends its message. This new message is then placed on the outgoing side of the ring.

Ring Topology (cont.)

- Each station passes on received tokens if they have nothing to transmit.
- They monitor connector messages to see if the message is addressed to them.
- If connector messages are addressed to them, they copy the message, modify it to signify its receipt, then send it on around the ring.
- Connector messages which are not addressed to them are passed directly on to the next station in the ring.
- When the connector message travels full circle and arrives at the original sending station, it checks the message to see if it's been received. It then discards the message and replaces it with a token.

Ring Topology (cont.).

Advantages and Disadvantages

■ Advantages

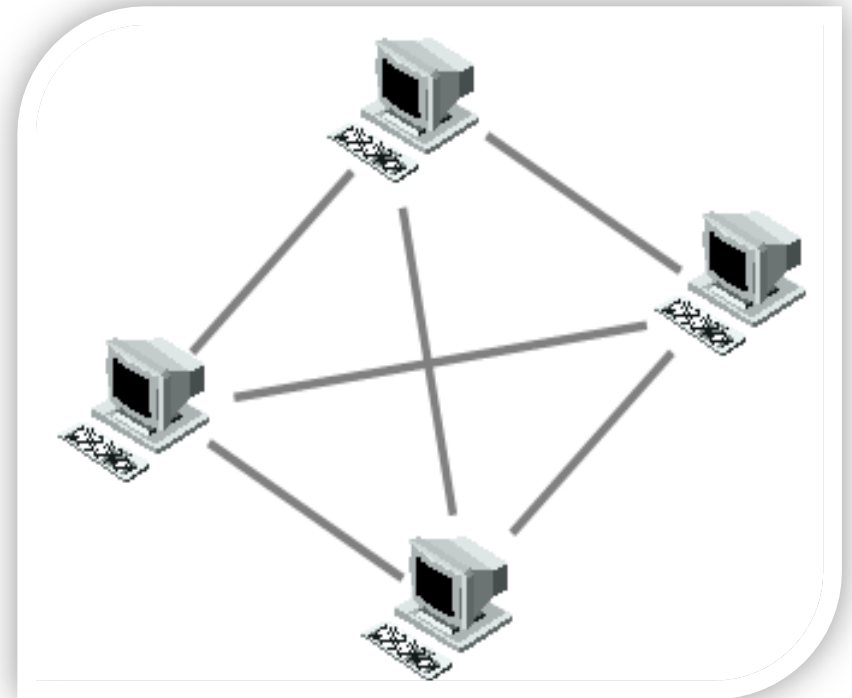
- Equal access for all users
- Perform well under heavy traffic

■ Disadvantages

- If one device/cable fails then the whole network goes down.
- Difficult to troubleshoot
- Adding/Removing computers disrupts the whole network

Mesh Topology

- In a mesh topology each device/PC is connected to every other device/PC in the network by its own cable.
- Mesh Types:
 - Full Mesh.
 - Partial Mesh.



Mesh Topology (cont.)

Advantages and Disadvantages

■ Advantages

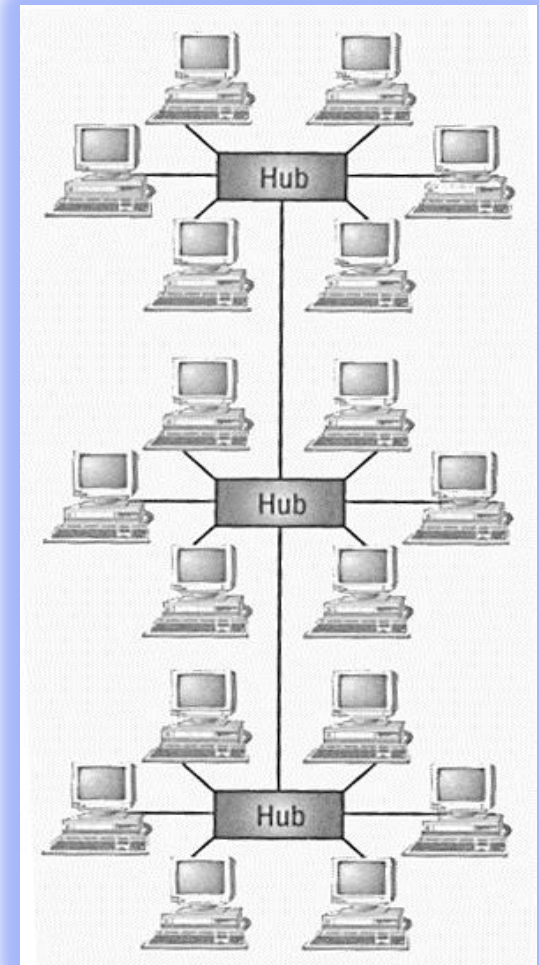
- Mesh topology boasts the highest fault tolerance of all of the network topologies

■ Disadvantages

- Because each connection needs its own cable a Mesh topology can get very expensive.

Hybrid Topologies

- Hybrid means that there is more than one topology exist
- Starred Bus
 - Groups of star-configured networks are connected to a linear bus backbone.
- **Advantages:**
 - Network expansion is simple
- **Disadvantages:**
 - If hub fails connections between failed hub and other hubs will fail

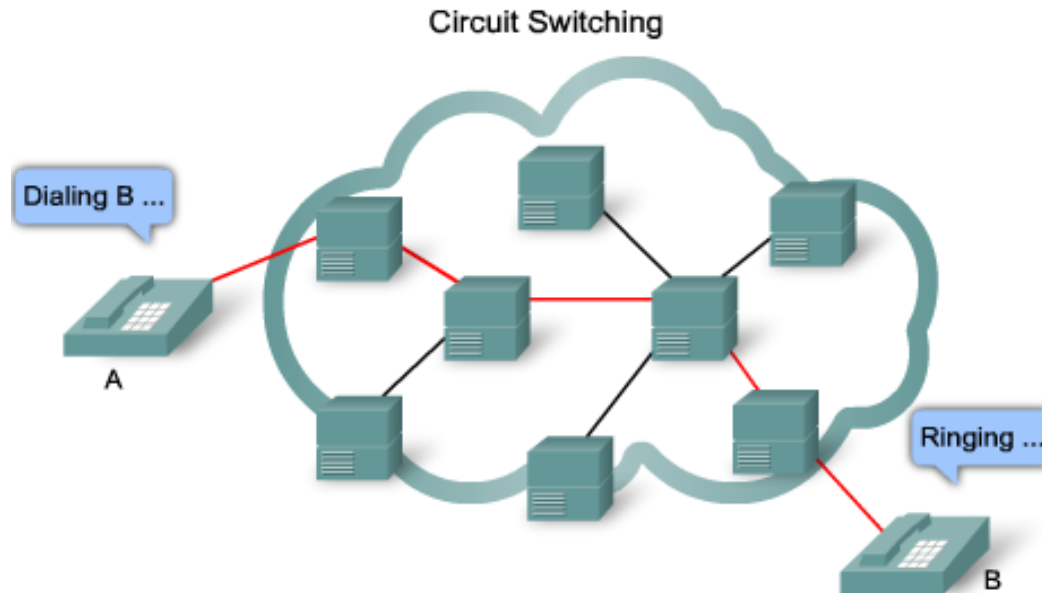


According to data Interchange Method

- Dedicated communication path between two stations
- Three phases
 - Circuit establishment
 - Data transfer
 - Circuit disconnect
- Must have switching capacity and channel capacity to establish connection
- Examples of circuit-switched communication links are analog dialup (PSTN)

According to data Interchange Method (cont.)

■ Circuit-switch communication



Circuit Switching – Properties(1)

- Inefficient

- Channel capacity dedicated for duration of connection

- If no data, capacity wasted

- Set up (connection) takes time

- Once connected, transfer is transparent

- Developed for voice traffic (phone)

Circuit Switching – Properties(2)

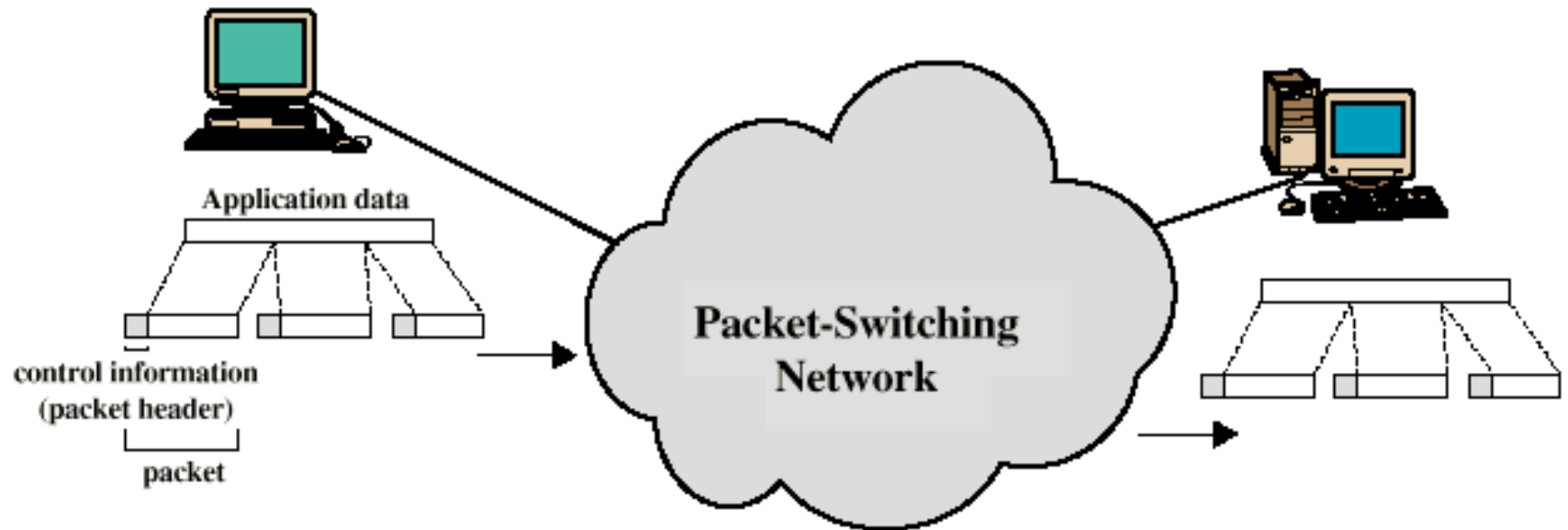
■ Inflexible

- The path taken remain the same as soon as it is established
- Assume single data rate for both communicating devices
- When traffic become heavy request for new connection is refused (**Blocking**)

Packet-Switching – Basics

- Data transmitted in small packets
 - Longer messages split into series of packets
- Each packet contains
 - **Payload** : portion of user data
 - **Header** : Control information (Routing and addressing information)
- Packets are received, stored briefly (buffered) and passed on to the next node

Packet-Switching – Use of Packets



Packet-Switching – Advantages(1)

- Line efficiency
 - Single node to node link can be shared by many packets over time
 - Packets queued and transmitted as fast as possible
- Data rate conversion
 - Each station connects to the local node at its own speed
 - Nodes buffer data if required to equalize rates

Packet-Switching – Advantages(2)

- Packets are accepted even when network is busy
 - Delivery may slow down but no blocking
- Priorities can be used



Network Transmission Media



Network Transmission Media

- To transmit data, a medium must exist
- The medium can be in the form of cables or wireless medium
- Most common used media for data networks
 - Twisted pair cable
 - Coaxial cable
 - Fiber optic cable
 - Wireless media

Network Transmission Media

■ Cable Media

■ Twisted Pair Cables

- STP

- UTP

■ Fiber Optic Cables

■ Coaxial Cables

■ Wireless Media

■ Infrared

■ Microwave

■ Bluetooth

Network Transmission Media

■ Cable Media

- There are several types of cable which are commonly used with LANs.
- In some cases, a network will utilize only one type of cable, other networks will use a variety of cable types.
- The type of cable chosen for a network is related to the network's topology, protocol, and size.

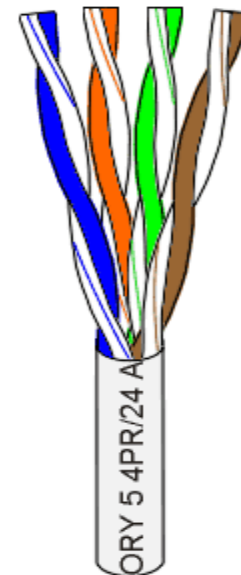
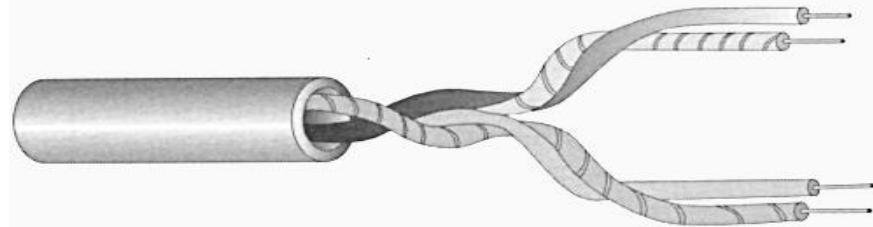
Twisted pair cable

- Most widely used (Ethernet networks)
- The segment can't exceed 100 meters
- Two basic types
 - STP
 - UTP
- Twisted pair cable has 7 categories
- Use RJ-45 connectors
- Crimper tool attach the twisted pair cable to RJ-45



Unshielded Twisted Pair (UTP)

- Low Cost
- Easy Installation
- Bandwidth ~
1,4,10,16,100,1000
Mbps
- Attenuation ~
hundred of meters
(high)



UTP Categories

- The UTP cables are classified into many types called categories:
 - Cat 1 : which supports up to 1 Mbps
 - Cat 2 : which supports up to 4 Mbps
 - Cat 3 : which supports up to 10 Mbps
 - Cat 4 : which supports up to 16 Mbps
 - Cat 5 : which supports up to 100 Mbps (this is the kind used in AEthernet networks)
- The principle upon which the UTP cables are classified is the amount of twisting, when the twisting amount is increased, the interference amount is decreased, . as a final result, the bandwidth the cable support increases

UTP Categories



(a)



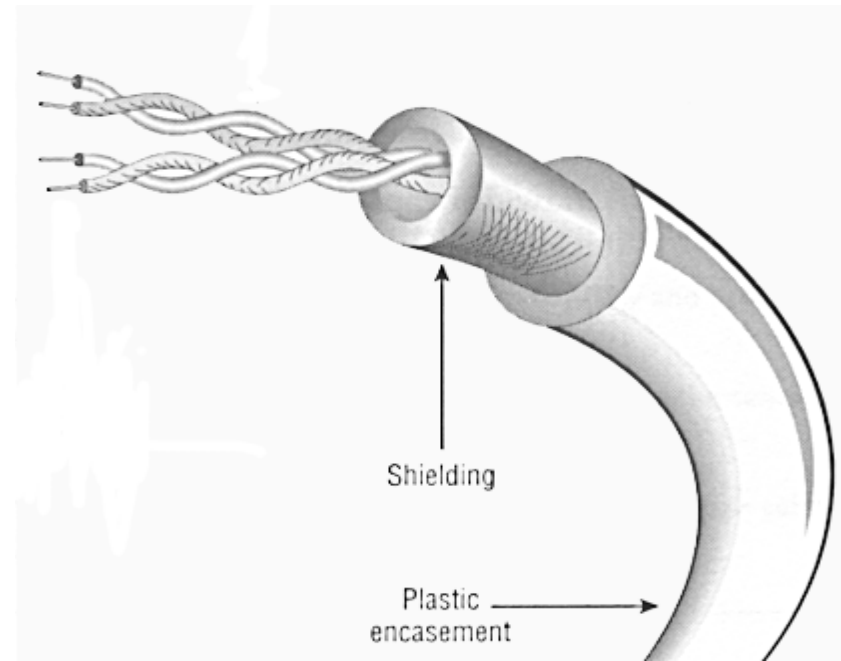
(b)

(a) Category 3 UTP.

(b) Category 5 UTP.

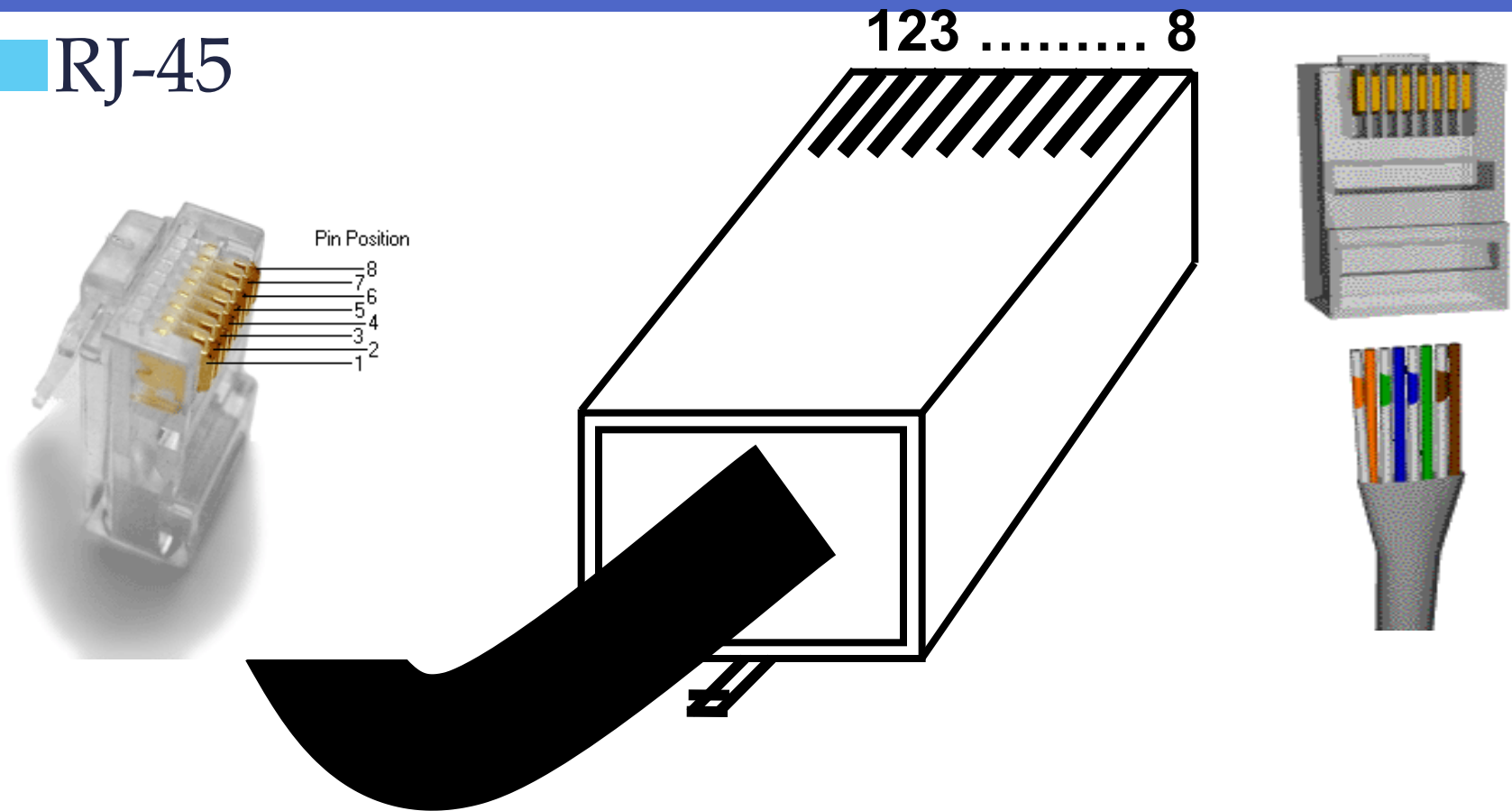
Shielded Twisted Pair (STP)

- Moderate Cost
- Fairly Easy Installation
- Bandwidth ~ more than same cat of UTP
- Attenuation ~ hundred of meters



Connector Used

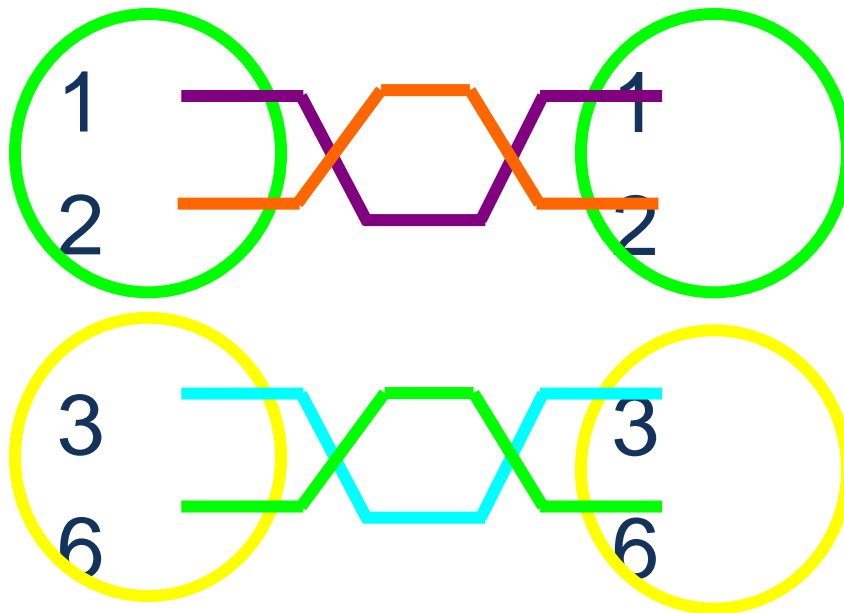
■ RJ-45



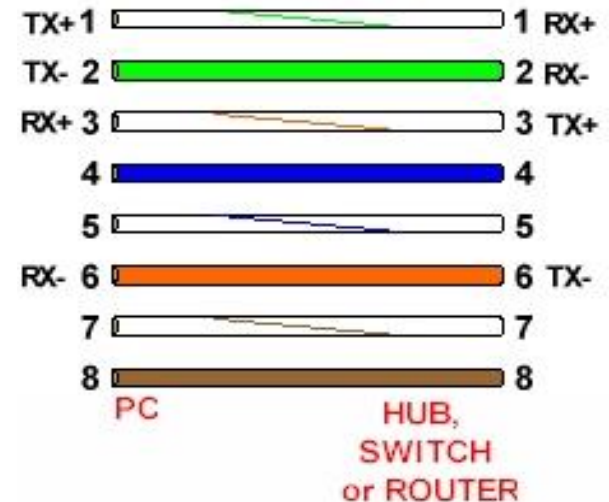
Twisted Pair Cable Connection Types

- Dropped Cable (Patch Chord / Straight)
- Cross-over Cable
- Rolled-over Cable

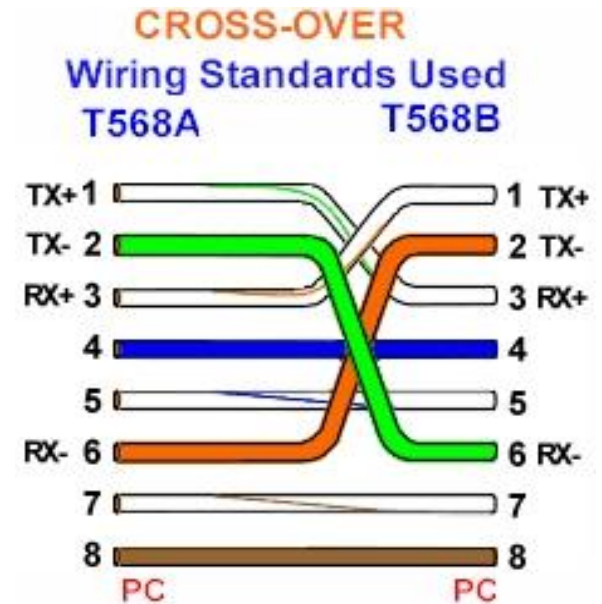
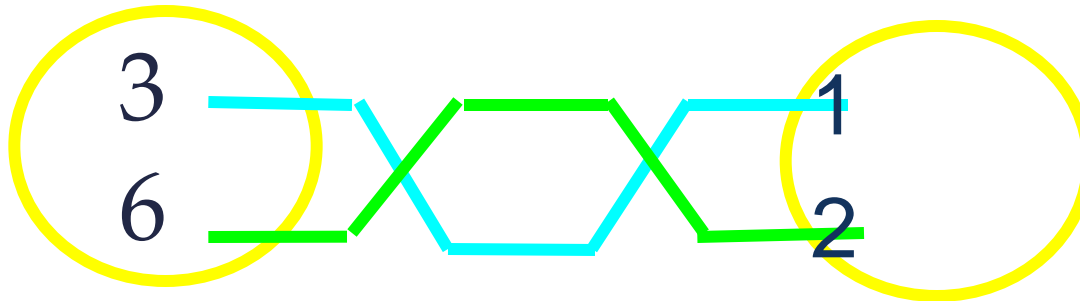
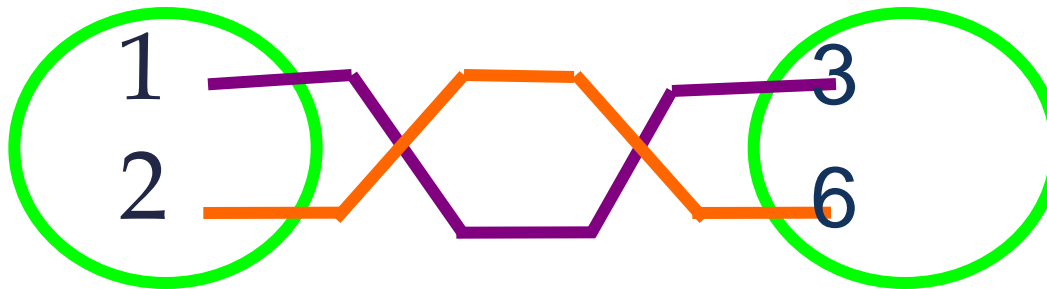
Dropped (Patch Chord / Straight) Cable



STRAIGHT-THROUGH Wiring Standards Used

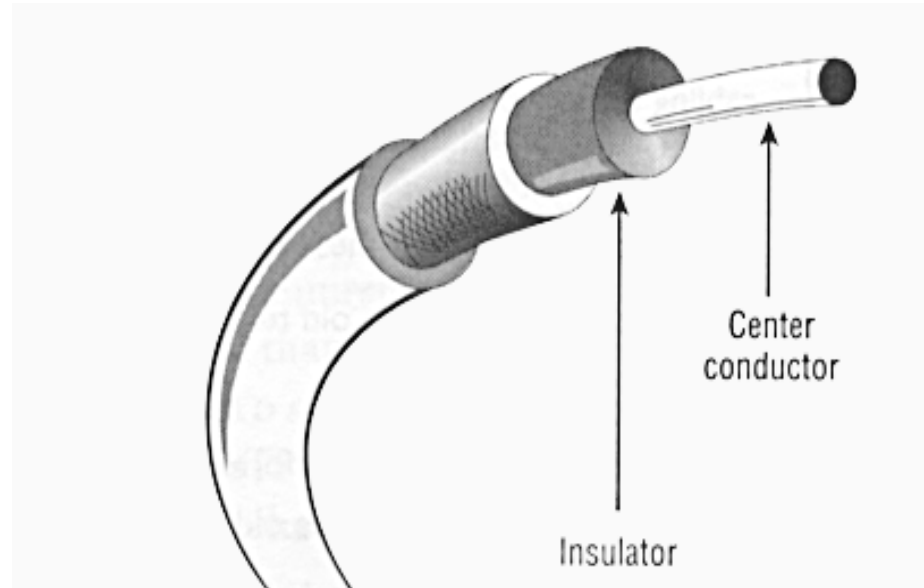


Cross-over Cable



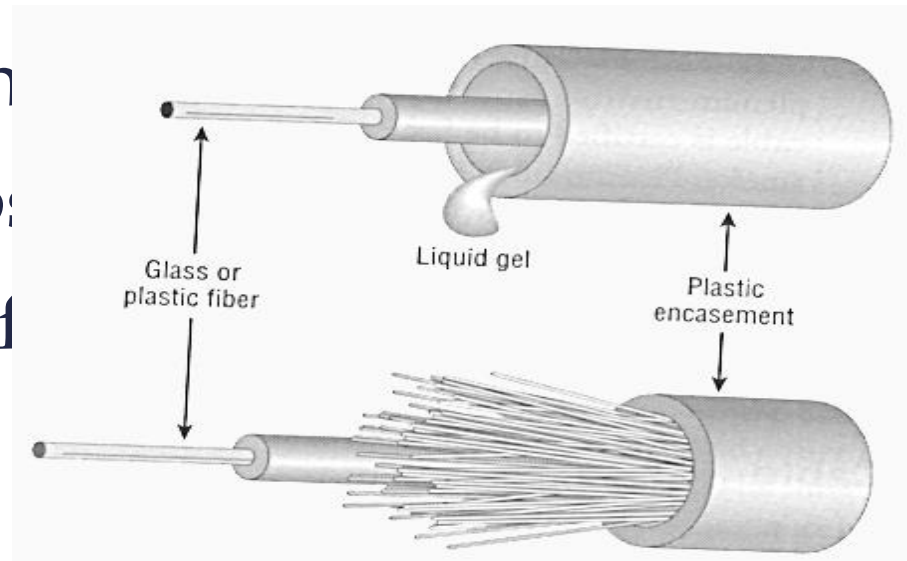
Coaxial

- Cost is Moderate
- Fairly Easy Installation
- Bandwidth ~ 10 Mbps
- Attenuation ~ few hundreds of meters



Fiber-optic

- Highest Cost
- Difficult Installation
- Bandwidth ~ 2 Gbps
- Attenuation \sim ten of kilometers (low)



Wireless Media

- Flexible (Used in areas where it is hard to install cables)
- Used in wireless LANs
- Hybrid environment is one which wireless components communicate with a network that use cables



Thank you

